

El Niño During the 1990's: Harbinger of Climatic Change or Normal Fluctuation?

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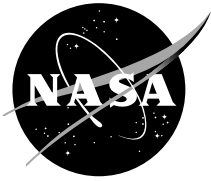
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TECHNICAL PUBLICATION

EL NIÑO DURING THE 1990'S: HARBINGER OF CLIMATIC CHANGE OR NORMAL FLUCTUATION?

1. INTRODUCTION

Today, El Niño refers to the extreme warming episodes of the globally effective, coupled ocean-atmospheric interaction commonly known as ENSO (i.e., “El Niño-Southern Oscillation”).¹⁻⁴ Concerning its observed decadal frequency and severity, El Niño during the 1990's has often been regarded as being anomalous.⁵⁻¹⁰ Results of analysis reported herein; however, appear to mitigate this belief. For example, regarding the frequency and severity of El Niño, the decade of the 1990's is found to compare quite favorably with that of preceding decades. Hence, the 1990's probably should not be regarded as being anomalous. On the other hand, the number of El Niño-related months per decade has sharply increased during the 1990's, as compared to the preceding four decades, hinting of a marginally significant upward trend. Perhaps this is an indication that the Earth is now experiencing an ongoing global climatic change. Continued vigilance during the new millennium, therefore, is of paramount importance for determining whether or not this “hint” of a global change is real or if it merely reflects a normal fluctuation of climate.

2. RESULTS AND CONCLUSION

Shown in figure 1 (lower panel) is the decadal frequency of moderate and stronger El Niño onsets (denoted by the filled circles) for the interval of 1800 to the present, taken from Quinn et al.¹¹ and Trenberth.³ One finds that the distribution looks like that of the normal distribution (upper left panel), having a strong peak at three onsets per decade and a range of one to four onsets per decade. Furthermore, there is no evidence of clustering regarding either the maximum rate of four onsets per decade or the minimum rate of one onset per decade, thereby inferring that the rates probably are randomly distributed. Hence, one strongly suspects that no significant increase has occurred in the decadal frequency of El Niño (at least, over the past 20 decades); i.e., the decadal frequency of the 1990's is inferred to be no different from that of preceding decades. (Regression analysis, likewise, supports this conclusion.)

Also shown in figure 1 (lower panel) is the decadal frequency of strong El Niño (denoted by filled triangles), having a strong peak at the rate of one onset per decade and a range of zero to two onsets per decade. As for the combined group of moderate and stronger El Niño, the lack of clustering of the maximum and minimum decadal rates suggests that the decadal frequency varies randomly; hence, the severity of El Niño probably has not increased in recent decades.¹²

Another way of examining the temporal variation of the severity of El Niño is to look at the change (with time) of the average duration for El Niño, since stronger (i.e., more severe) events tend to also be events of longer duration. Unfortunately, an extensive listing of precisely determined events is available only since the 1950's.³

Plotted in figure 1 (middle right panel) is the average duration of El Niño for each of the past five decades. Although one may visually reckon an upward increase over time of the average duration, regression analysis (not shown) suggests that no significant upward trend has occurred. Thus, this too indicates that no statistically important change in the severity of El Niño has occurred, at least in recent years. (It is fascinating, however, that even decades like the 1960's and 1980's are found to display an average duration for El Niño that is longer than that found for the odd decades like the 1950's, 1970's, and 1990's. If this pattern continues, then obviously, one must expect that the average duration of El Niño during the coming even decade will be longer than a year per episode, perhaps even considerably longer.)

While true, interestingly, one finds that the variation in the number of El Niño-related months per decade appears to have increased over the past five decades (fig. 1, upper right panel), although strictly speaking, the inferred upward trend is only of marginal statistical significance. During the 1990's, some 49 months (about 41 percent) are found to have been El Niño related, with this value representing the sum of the individual durations for the four El Niño that occurred during the 1990's. For the first decade of the new millennium, extrapolation of the inferred trend suggests that the number of El Niño-related months will total about 49 ± 11 mo (the 90-percent prediction interval). (It is interesting that given the total number (49) of El Niño-related months for the next even decade, 2000–2009, and presuming that it will also have an average number of three El Niño onsets, one finds that the average duration per episode should be ≈ 16 mo in length. Such a finding is found to be supportive of the aforementioned view that even decades have an average duration longer than odd decades.)

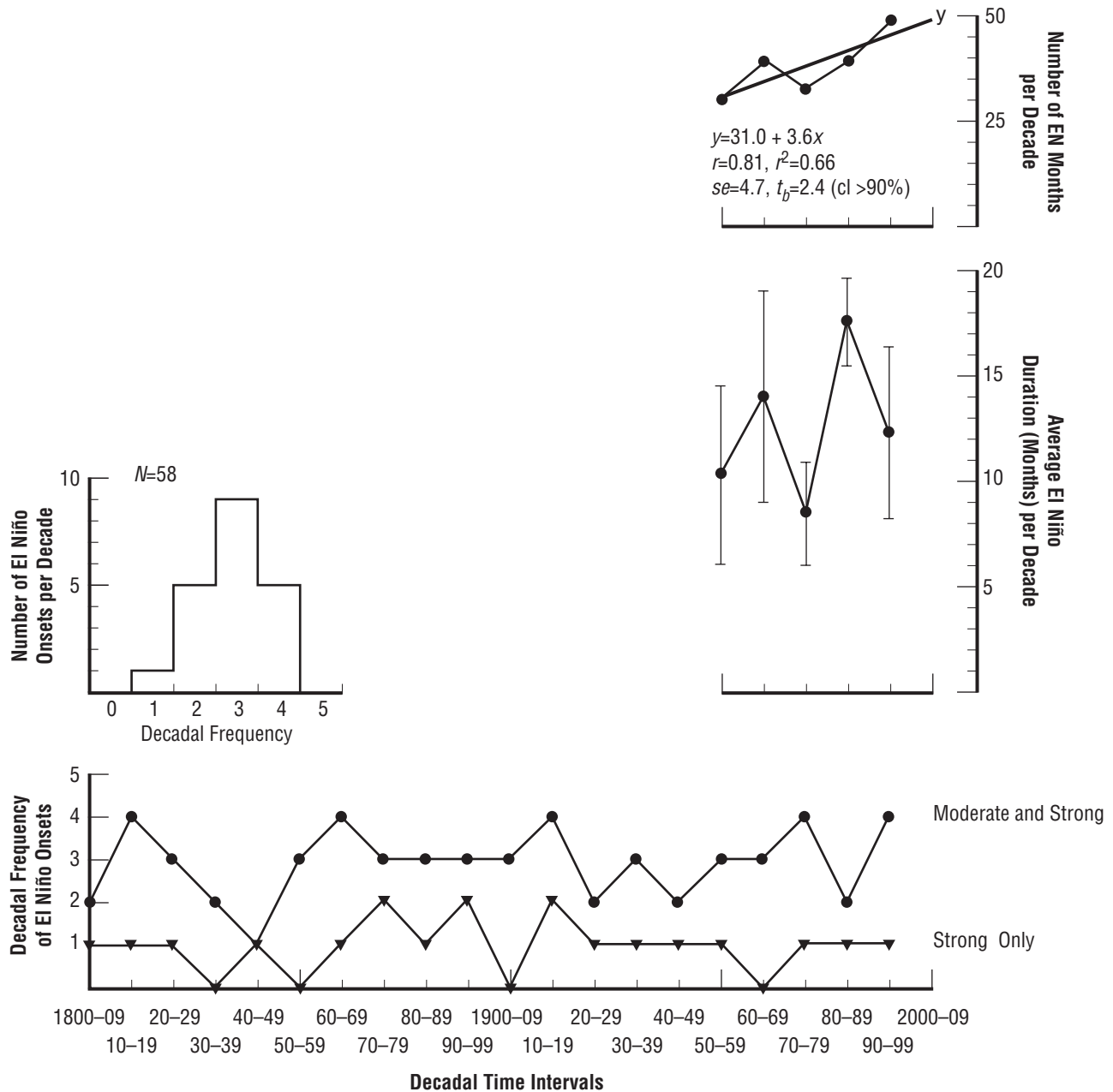


Figure 1. The decadal frequency of El Niño onsets, 1800–present (lower panel), where filled circles refer to moderate and stronger events and filled triangles refer to stronger events only; the distribution of decadal frequency (upper left panel), where the number of El Niño for the past 20 decades is $N=58$; the average El Niño duration per decade in months, 1950–present (middle right panel), where the thin vertical lines are the ± 1 standard deviation spreads about the averages; and the number of El Niño-related months per decade, 1950–present (upper right panel), where y is the inferred regression equation, x is the decade (0=1950's, 1=1960's, and so forth), r is the coefficient of correlation, r^2 is the coefficient of determination (i.e., the percentage of the variance explained by the regression), se is the standard error of estimate, and t_b is the t statistic for the slope of the inferred regression.

In summary, statistical inferences concerning the decadal frequency and severity of El Niño have not yet revealed any basis for presuming significant upward trends to exist within them; hence, the 1990's should not be regarded as being anomalous. On the other hand, the number of El Niño-related months per decade appears to hint of an upward trend, albeit one that is only of marginal statistical significance (and the average duration per decade has been longer for even decades than for odd decades). If this trend continues to be seen in the coming decades of the new millennium, then this may be an indication that a long-term, ongoing global climatic change is presently underway;¹³⁻¹⁷ otherwise, it may merely reflect a natural fluctuation of climate. Continued vigilance in the coming decades seems warranted.

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operation and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503				
1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE February 2000		3. REPORT TYPE AND DATES COVERED Technical Publication
4. TITLE AND SUBTITLE El Niño During the 1990's: Harbinger of Climatic Change or Normal Fluctuation?			5. FUNDING NUMBERS	
6. AUTHORS Robert M. Wilson				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) George C. Marshall Space Flight Center Marshall Space Flight Center, AL 35812			8. PERFORMING ORGANIZATION REPORT NUMBER M-964	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546-0001			10. SPONSORING/MONITORING AGENCY REPORT NUMBER NASA/TP-2000-209960	
11. SUPPLEMENTARY NOTES Prepared for Space Science Department, Science Directorate				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unclassified-Unlimited Subject Category 47 Standard Distribution			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Today, El Niño refers to the extreme warming episodes of the globally effective, coupled ocean-atmospheric interaction commonly known as ENSO (i.e., "El Niño-Southern Oscillation"). Concerning its observed decadal frequency and severity, El Niño during the 1990's has often been regarded as being anomalous. Results of analysis reported herein; however, appear to mitigate this belief.				
14. SUBJECT TERMS ENSO, El Niño, climatic change, climate			15. NUMBER OF PAGES 12	
			16. PRICE CODE A03	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited	